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[CHD 8: Occupational Safety, Health and Chemical Hazards]

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IS : 10920 - 1984

Indian Standard

CODE OF SAFETY FOR PHOSPHORUS TRICHLORIDE

UDC 614·878 : 661·638

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3 *August* 1984

AMENDMENT NO. 1 DECEMBER 2006
TO
IS 10920 : 1984 CODE OF SAFETY FOR PHOSPHORUS TRICHLORIDE

(*Page* 5, *clause* **4.1**) — Substitute the following for the existing:

'**Threshold Limit Value**: TLV - TWA : 0.2 ppm, TLV-STEL: 0.5 ppm'

(CHD 8)

Reprography Unit, BIS, New Delhi, India

Indian Standard

CODE OF SAFETY FOR PHOSPHORUS TRICHLORIDE

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(*Continued on page* 2)

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(*Continued on page* 12)

Indian Standard

CODE OF SAFETY FOR PHOSPHORUS TRICHLORIDE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 April 1984, after the draft finalized by the Chemical Hazards Sectional Committee had been approved by the Chemical Division Council.

0.2 Phosphorus trichloride is an industrial chemical used in organic syntheses, especially of some organophosphorus insecticides, as a chlorinating agent, in the manufacture of other phosphorus chloride compounds and in the production of iridescent metallic deposits.

0.3 Although phosphorus trichloride is itself not combustible, its reaction with water produces hydrochloric acid which may constitute a moderate fire hazard due to reaction of these acids with most metals to give off hydrogen. Phosphorus trichloride vapour is a severe irritant of the eyes, mucous membranes and skin. It is corrosive to most common metals.

0.4 In the preparation of this safety code, considerable assistance has been derived from the following publications:

Chemical safety data sheet SD-27 'Phosphorus trichloride', 1972. Manufacturing Chemists Association, Washington, D.C.

PROCTOR (N H) and HUGHES (J P), Chemical Hazards of the Workplace. 1978. J.B. Lippincott Company, Philadelphia, U.S.A., pp. 420-421.

1. SCOPE

1.1 This code describes properties of phosphorus trichloride, nature of hazards associated with it, symptoms of poisoning, measures for first-aid and medical treatment, safety measures for controlling hazards in storage, handling and transport, decontamination of containers and spillage, and requirements for safety education of employees in industry.

1.2 This code does not deal with specifications for design of buildings, containers, chemical engineering and safety equipments and methods of manufacture.

2. TERMINOLOGY

2.1 For the purposes of this code, the definitions given in IS : 4155-1966* and IS : 4167-1966† shall apply.

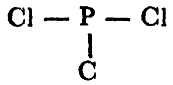
3. GENERAL INFORMATION, PROPERTIES, ETC

3.1 General Information

3.1.1 *Common Name* — Phosphorus trichloride, Phosphorus chloride

3.1.2 *Chemical Name* — Phosphorus trichloride

3.1.3 *Empirical Formula* —



$\mathrm{Cl - \underset{\overset{|}{C}}{P} - Cl}$

3.1.4 *Molecular Formula* — PCl_3

3.1.5 *Molecular Weight* — 137·35

3.2 Physical Properties

3.2.1 *Description* — Colourless to light yellow clear liquid with pungent and irritating odour, resembling hydrochloric acid fumes in air.

3.2.2 *Freezing Point* — minus 111·8°C

3.2.3 *Boiling Point* — 76°C

3.2.4 *Specific Gravity* — 1·573 at 20°C
(water at 4°C = 1)

3.2.5 *Vapour Pressure* — 13·3 kPa at 21°C
(volatilizes at ordinary temperature)

3.2.6 *Solubility* — Soluble in benzene, ether, carbon disulphide and carbon tetrachloride.

3.3 Chemical Properties

3.3.1 *Affinity for Other Chemicals* — Phosphorus trichloride reacts immediately with acetic acid, aluminium, chromyl chloride, fluorine, dimethyl sulfoxide, hydroxylamine, iodine, nitric acid, etc.

3.3.2 *Important Common Reactions* — It reacts with water, aqueous solutions, alcohol and many other organic compounds to liberate heat, hydrochloric acid and phosphorus acids.

3.3.3 *Stability at High Temperature* — It volatilizes at ordinary temperature.

---

*Glossary of terms relating to chemical and radiation hazards and hazardous chemicals.

†Glossary of terms relating to air pollution.

3.3.4 *Whether Flammable, Non-Flammable or Supporter of Combustion* — Although phosphorus trichloride is itself not combustible, its reaction with water produces hydrochloric acid and acids of phosphorus which may constitute a moderate fire hazard due to reaction of these acids with most metals to give off hydrogen. Reaction with water may generate phosphine or phosphorus which are flammable.

3.4 Corrosion Properties

3.4.1 Phosphorus trichloride is corrosive to iron if not protected fully from moisture.

3.4.2 Phosphorus trichloride is corrosive to most common metals except nickel and lead.

4. INFORMATION ON HEALTH EFFECTS AND TOXICITY

4.1 Threshold Limit Value (ACGIH) — 0·5 ppm or 3 mg/m^3.

4.2 Routes of Entry — These range from irritation of eyes, nose, throat and mild bronchial spasm (mild exposure) to burns of eyes, skin and severe pulmonary edema (severe cases). Expectoration may contain blood.

4.3 Health Effects — Symptoms may be delayed, that is, in severe cases, respiratory symptoms may occur after two to 6 hours, while in moderate exposure the onset of symptoms may not occur until 12 to 24 hours later. By analogy, with effects caused in animals, kidney damage may be observed. In mild exposure resulting in mucous membrane irritation, the symptoms may mimic a viral upper respiratory tract infection. The latter may be characterized by fever, myalgias and lymphocytosis. As the tracheobronchial tree and pulmonary parenchyma become involved, the symptoms and signs shall be differentiated from cardiogenic pulmonary edema, severe viral or bacterial pneumonia, and adult respiratory distress syndrome.

5. STORAGE, HANDLING AND TRANSPORTATION

5.1 Storage

5.1.1 Always store dry phosphorus trichloride in clearly labelled dry steel, glass, earthenware containers lined with lead, nickel or other impervious material.

5.1.2 Good ventilation should be provided to have enough air transfer.

5.1.3 Flooring should be acid proof such that any leaks or spills do not damage flooring.

5.1.4 It is desirable to have fire-proof electric fittings in the storage areas.

5.1.5 Fire protection measures should be taken in storage areas.

5.2 Handling and Transfer

5.2.1 In industrial use, phosphorus trichloride can be handled without hazard provided the following basic measures are effectively implemented:

a) Proper safety education and training of all supervisors and employees;

b) Provision and use, when needed, of personal protective clothing and equipment, together with essential safety devices and rapid communication facilities; and

c) Strict supervision of all employees assigned to jobs in which injury due to phosphorus trichloride is possible.

Mechanized loading and unloading of containers helps to minimise chance exposure of operators to phosphorus trichloride. While opening drums and transferring material by gravity, pump or vacuum methods using suitable nickel, glass, stainless steel or lead lines, due care should be taken to protect all equipment from moisture and to protect operators with suitable personal protective clothing and equipment. Do not heat glass flasks containing phosphorus trichloride on water bath.

5.2.2 Spillage of phosphorus trichloride should be absorbed in Fuller's earth or dry sand.

5.3 Transport

5.3.1 For inplant transport, mechanized loading and unloading of containers helps to minimise chance exposure of operators to phosphorus trichloride.

5.3.2 Due care should be taken during transport to protect containers from water, organic chemicals and heat.

6. FIRE FIGHTING

6.1 Though phosphorus trichloride is neither flammable nor explosive, the reaction with water is very violent. Small amounts leaking into drains or ditches carrying water can cause flashes of fire which is particularly hazardous if it occurs in operating buildings. These flashes of fire may also occur when opening or washing empty drums or other containers used for shipment or storage of phosphorus trichloride, and from the reaction of phosphorus trichloride with organic matter. Dry chemical powder extinguisher can also be used.

If fire occurs which releases large quantities of phosphorus trichloride, large quantities of sand should cover the spillage of phosphorus trichloride and a carbondioxide based fire extinguisher should be used for fighting the fire.

6.2 Water should not be used for fire fighting.

7. SPILLAGE, LEAKAGE AND DISPOSAL OF MATERIAL

7.1 Equipment and container should be frequently inspected to detect and prevent leaks. If leaks or spills of phosphorus trichloride occur and its vapours become strong enough to be noticed, only properly protected personnel should remain in the area.

7.2 Spilled phosphorus trichloride should never be left unattended to. The recommended method for use in cleaning up spillage consists of absorbing it in Fuller's earth or dry sand.

7.3 After absorbing the spilled phosphorus trichloride, the Fuller's earth or dry sand can be shovelled into dry metal containers and carried to an isolated area where it can be dispersed and flooded with water or emptied into a large volume of water. The area treated with Fuller's earth or dry sand should then be flooded with large amounts of water.

7.4 Maximum ventilation should be provided in the case of leaks or spillage occuring indoors. If the container shows signs of leakage it should be moved outdoor or to an isolated, well-ventilated area where its contents can be transferred safely to suitable containers while protecting phosphorus trichloride from exposure to water.

8. WASTE DISPOSAL

8.1 Generally liquid waste contains phosphorus trichloride only. Gaseous waste contains either phosphorus trichloride vapours or hydrogen chloride and phosphorus acids resulting from the reaction of phosphorus trichloride and water.

8.2 To dispose off small quantities of waste phosphorus trichloride (up to 5 kg) it should be sprinkled or added cautiously onto a thick layer of mixed soda ash and slaked lime (50-50) from behind a body shield. Water should be mixed and then sprayed cautiously with an atomizer. The residue mixture is then scooped and shifted into a large volume of water. Finally it should be neutralized and washed down the drain with large excess of water.

For the disposal of large quantities, the user should consider the possibility of returning the contaminated material to the supplier for reprocessing.

9. FIRE PREVENTION

9.1 It is desirable to go for flameproof electrical equipment.

9.2 Though phosphorus trichloride is neither flammable nor explosive, it is advisable to control ignition sources like open flames because on contact with water, phosphorus trichloride gives hydrochloric acid which after the reaction with metal gives out hydrogen gas which can be ignited with explosive force.

9.3 Earthing of individual equipment is desirable in the plant and these earthings should be firmly connected with the main earthing station.

10. HAZARD INFORMATION

10.1 Phosphorus trichloride is classified as corrosive liquid. The word 'CORROSIVE' should be marked on the label. Along with this it is desirable to put 'CARGO FIRE -- AVOID WATER' (or words of similar nature).

10.2 The following notices shall be displayed in the plant:

DO NOT BREATHE VAPOUR
WASH THOROUGHLY AFTER HANDLING
AVOID CONTACT WITH EYES, OR SKIN, OR CLOTHING.

10.3 The following information should be given on the label:

AVOID CONTACT WITH EYES, OR SKIN, OR CLOTHING.
DO NOT BREATHE VAPOUR
KEEP CONTAINER CLOSED
USE WITH ADEQUATE VENTILATION
WASH THOROUGHLY AFTER HANDLING
DESTROY THE CONTAINER

11. PERSONAL PROTECTIVE EQUIPMENT

11.1 Non-respiratory Protective Devices to be Used

a) Chemical safety goggles, cup-type rubber framed or plastic goggles with impact resistant glass;

b) Face shields: Plastic shields full length 200 mm minimum with forehead protection;

c) Safety shoes, hat, gloves made of rubber may be used to guard against liquid leaks or splashes; and

d) Full body overalls should also be worn and all contaminated clothing should be removed promptly and laundered and thoroughly dried before use.

12. TRAINING AND EDUCATION

12.1 Occupational safety depends to a great extent upon the effectiveness of employee or worker education, proper safety measures, intelligent supervision and the use of safety equipment, protective clothing and maintenance of strict personal hygiene. Preplacement training on safety should be given to each employee.

12.2 Regular training classes should be conducted to maintain a high degree of safety in procedures for handling, storage and tank-filling, repairs and cleaning. Supervisors and workers must be thoroughly informed of the hazards associated with improper handling of phosphorus trichloride. Each employee should know what to do in an emergency and should be fully aware of first-aid measures.

12.3 Each employee should be given refresher training after certain interval of time.

13. HEALTH MONITORING

13.1 Diagnostic studies of persons for pre-employment should include electro-cardiogram, sputum—gram stain and culture, differential white blood cell count, and arterial blood gas analysis.

13.2 The medical examination should take place every year.

13.3 Maintenance of Records

13.3.1 Proper records should be kept of medical examinations.

14. FIRST AID

14.1 Actions in Emergency

14.1.0 *General* — In all cases of contact or injury with phosphorus trichloride liquid or vapour, remove victim at once from source of chemical and decontaminate thoroughly as follows before arrival of physician.

14.1.1 *If Skin Affected* — Remove contaminated clothing, shoes and gloves and deluge skin thoroughly and continuously with water for at least 5 minutes. If skin is affected washing contamination at ears and body with 5 percent copper sulphate solution, then wash with soap and water and then treat the skin burns as for normal treatments.

14.1.2 *If Eyes Affected* — Immediately irrigate eyes/conjuctive with clean water, that is, from an eyewash fountain, for at least 15 minutes, keeping lids open. Following initial fountain washing, the eyes should be washed for a second period of 15 minutes at the medical facility. No attempt should be made to neutralize the chemical in the eyes. Avoid eye ointments. Speedy examination and treatment by a physician, preferably an ophthalmologist is essential.

14.1.3 *If Inhaled* — Remove victim to open and fresh air. If breathing has stopped, give artificial respiration, with oxygen if available. Immediate hospitalization and observation for 72 hours for delayed onset of severe pulmonary edema are advisable.

14.1.4 *If Ingested or Swallowed* — Give large quantities of water if victim is conscious and able to swallow. Do not induce vomiting. If vomiting does occur, give additional water to replace what is lost. An ounce of olive oil may be given if available. Do not give baking soda or other alkaline solutions. As ingestion may be followed by shock, keep patient warm and quiet, and lying down, if possible. Do not give stimulants or morphine, unless ordered by physician. Avoid mouth-to-mouth artificial respiration.

14.2 Suggestion to Physicians Rendering Medical Aid

14.2.1 *If Skin is Affected* — Applications of wet dressings for 15 to 20 minutes 3 or 4 times daily for 2 to 3 days may be used in cases of acute dermatitis with vesiculations. Systemic steroids may be used, usually for not more than 7 to 10 days. Additional treatment includes oral histamines for sedation and relief of itching and complete rest and protection of the involved skin.

NOTE — Corticosteroids shall not be given to persons having active or questionably active tuberculosis, herpes simplex, keratitis or skin infection, or acute psychosis.

14.2.2 *If Inhaled* — Obtain chest X-ray and examine for infiltrate perform analysis of arterial blood gases. Maintain arterial oxygen pressure above 60 mm Hg by instituting in stop-wise fashion by one of the following measures, as needed:

a) Administer 60 to 100 percent oxygen by mask or cannula,

b) Endotracheal intubation and mechanical ventilation, and

c) Intermittent use of positive and expiratory pressure (PEEP) breathing apparatus.

Fluid balance shall be maintained, use of a diuretic may be required. Steroids may be administered on a short-term basis (two to four days) to decrease the inflammatory response of the lungs.

14.2.3 *If Ingested* — Treatment for shock may be needed. Do not use stomach tubes, emetics or sodium bicarbonate. Neutralize with aluminium hydroxide, milk of magnesia, milk, chalk or egg white. When indicated, 0·5 g caffeine, sodium benzoate may be injected intramuscularly. For severe pain, 8 to 15 mg morphine sulphate may be given intravenously.

14.2.4 *Medical Surveillance* — Preplacement and regular, for example, quarterly physical examination with emphasis on the respiratory tract and kidneys is recommended.

(*Continued from page* 2)

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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